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MONTANA REFERENCE STREAMS ANNUAL SUMMARY:

1994 AQUATIC MACROINVERTEBRATE DATA AND RBP CRITERIA EVALUATION

prepared for the

Montana Department of Health and Environmental Sciences

Helena, MT

prepared by

Daniel L. McGuire
Aquatic Biologist
Espanola, NM

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Montana reference streams annual summary
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Summary

The Montana Department of Health and Environmental Sciences (MDHES) has conducted macroinvertebrate surveys of least-impacted reference streams on four dates since 1990. The 1994 data from 11 reference streams (Table 1) are presented and incorporated into the existing database for Montana Reference streams. Data were summarized and metric variability within and among reference streams was evaluated. To date, RBP criteria have been based on the limited reference stream data and professional judgment. In this report, data from the reference streams and 45 other Montana streams were used to validate, refine and otherwise evaluate metrics and scoring criteria for stream assessments.

Plains ecoregion

Data for plains reference streams were highly variable and did not provide an adequate baseline for establishing RBP criteria. In fact, most reference stream collections indicated poor biologocal integrity. Much of the variability within and among references streams was attributable to variable flow regimes which sometimes forced sample collection from different or marginal habitats. Samples from streams subject to dewatering and/or lacking riffles tended to result in low metric values and high variability. Revised sampling protocols for low-gradient streams (Bukantis 1995) address this problem. The "20 jab" sampling technique needs to be tested and compared with riffle samples from the same stream when ever possible. Different metrics and/or separate criteria may be required when sampling different habitats.

A database consisting of 16 reference stream samples and 22 additional stream assessments was used to evaluate and refine criteria for the plains ecoregion. Predetermined percentiles from this composite database were used as possible thresholds for defining scoring criteria. Based on this analysis, RBP criteria were revised for five metrics (Table 12).

The analysis of this composite database was extremely helpful in furthering our understanding of metric performances in plains streams; however, the database remains too small to provide definitive scoring criteria. Additional data from a wide range of plains streams should be collected. Sampling frequency for mountain reference streams could safely be reduced to every other year with the resources used to gather additional data from the plains ecoregion.

Mountain ecoregion

The mountain reference stream data provides a good characterization of nonimpaired streams in this ecoregion. Metric values have been consistent throughout the period of record and the addition of the 1994 data did not significantly change means, ranges or variability of any metric. An evaluation of data from 41 mountain stream samples indicated that current RBP metrics and criteria readily differentiate between impaired and non-impaired sites.

TABLE OF CONTENTS

	page
INTRODUCTION	1
METHODS	2
Field	2
Laboratory	2
Data Analysis	2
RESULTS AND DISCUSSION	3
Plains Ecoregion	3
Community composition	3
Metrics	5
RBP criteria	6
Mountain Ecoregion	8
Community composition	8
Metrics	8
RBP criteria	9
Armstrong Spring Creek	9
Tables	10
Figures	30
SUMMARY, CONCLUSIONS and Recommendations	37
LITERATURE CITED	38
APPENDICES	40
A. 1994 reference streams macroinvertebrate data	40
B. Functional feeding groups, voltinism designation and biotic index, metals tolerence index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.	64

Introduction

The Montana Department of Health and Environmental Sciences (MDHES) has conducted macroinvertebrate surveys of least-impacted reference streams since 1990. The reference stream program was described by Bahls et al. (1992). Previous studies (Wisseman 1992, McGuire 1992, 1994a) produced first generation metrics and criteria for macroinvertebrate-based Rapid Bioassessment Protocols (RBP) evaluations of biological integrity in montane, plains, and foothills and valleys regions.

The 1994 data from 11 reference streams (Table 1) are presented and incorporated into the existing database for Montana Reference streams (McGuire 1994a). Data were summarized and metric variability within and among reference streams was evaluated. To date, RBP criteria have been based on the limited reference stream data and professional judgment. In this report, data from the reference streams and 45 other Montana streams were used to validate, refine and otherwise evaluate metrics and scoring criteria for stream assessments.

Methods

Field

Field work was conducted by Montana Water Quality Bureau (WQB) personnel during the summer of 1994. Macroinvertebrates were collected from riffle habitats using a standardized traveling kick-net technique (Bukantis 1994). In 1994, a single sample was collected from each stream. Most sampling locations were established in 1990; however, additional plains reference streams were included in 1992, 1993 and 1994. Battle Creek was sampled in 1993 and 1994 while Woody Island Coulee was sampled in 1992 and 1994.

Laboratory

Laboratory and data analysis were contracted to McGuire Consulting. A 300 organism subsample was obtained from each sample using RBP III sorting methodology (Plafkin et al. 1989 - Appendix B.2). Macro-invertebrates were identified to the lowest practical taxonomic level, usually genus or species.

Data Analysis

Data from previous years were reviewed and additional metrics were calculated. Reference stream data were incorporated into a four year database for each ecoregion. Community composition, structure and function were characterized for each sample using a variety of potential metrics (Table 2). Database summaries included means, ranges, average deviations from the mean, and relative percent differences (R%Dif) of selected metrics. Descriptions, rationales and formulas for these metrics can be found in Wisseman (1992), McGuire (1992, 1993, 1994a) and other references sited in Table 2. Taxonomic levels, functional feeding group designations and tolerance values (Appendix B) used to calculate metrics were taken from previous studies as cataloged by Bukantis (1995).

Additional analyses utilized reference stream data and other comparable data from Montana streams. Based on previous assessments, data from 41 mountain streams were assigned to three classes of impairment (Table 3). The performances of nine metrics were evaluated using graphs of means, average deviations from the mean, and ranges for each impairment class. For plains streams, data from 38 assessments (Table 4) were compiled in a single database. Ten potential metrics were evaluated and possible criteria were defined by upper and lower quartiles and/or other pre-selected percentiles.

Results and Discussion

Eleven reference streams were evaluated in 1994 (Table 1). Samples were collected from five mountain and five plains streams. Armstrong Spring Creek was the only "reference stream" in the foothills and valleys ecoregion. The 1994 data, including identifications, taxon abundances, and metric values are presented in Appendix A.

PLAINS ECOREGION

Single samples were obtained from the West Fork Poplar River, Redwater River, Battle Creek, Rock Creek and Woody Island Coulee during 1994. These data were compared with data from the previous years and metric values from all four years were summarized.

Community composition

The composition of macroinvertebrate assemblages in plains reference streams changed substantially from 1990 to 1994. Initially, the benthic fauna in plains streams was dominated by dipterans (56%). Hemipterans, damselflies and scuds were also abundant while caddisflies and mayflies were minor components of the fauna. The mean combined relative abundance of caddisflies and mayflies was only 12% in 1990, but increased to approximately 50% in subsequent years. At this level of taxonomic resolution (Figure 1), community composition changed dramatically between 1990 and 1991, but was fairly similar in 1991, 1993 and 1994.

Year-to-year variability in community composition was evaluated further by examining the numerically dominant macroinvertebrate genera during each year. For each year, the ten most abundant taxa in plains reference streams were considered (Table 5). Mayflies and caddisflies replaced dipterans as the dominant taxa in plains reference streams during the five year monitoring period. In 1990, dipterans accounted for five of the ten most abundant taxa while only one mayfly and no caddisflies were numerically dominant. In 1991, the numerically dominant taxa included three dipterans, two mayflies and one caddisfly. This trend continued in 1993 when two dipterans, four mayflies and two caddisflies were abundant. In 1994, two dipterans, three mayflies and three caddisflies were numerically dominant. In addition to the changes in dominant insect taxa, *Gammarus* replaced more tolerant *Hyalella* as the most abundant noninsect taxon. Considering the 10 most abundant taxa each year, 1990 had a maximum of four dominants-in-common with any other year. In contrast, seven dominant taxa were common to 1993 and 1994. Only *Simulium* and water boatmen (a composite of at least four species in the family Corixidae) have been abundant during all four years.

As in previous years (McGuire 1994a), community composition varied significantly in 1994 among reference streams (Table 6). Mayflies dominated in the West Fork Poplar River while the most abundant taxa in the Redwater River, Rock and Battle creeks were, respectively, three different caddisfly genera. The scud, *Gammarus*, was the most abundant macroinvertebrate in Woody Island Coulee.

Faunal similarity among plains reference streams in 1994 was quantified using three similarity indices (Table 7). The Qualitative Similarity Indices (QSI-taxa and QSI-ffg) describe taxonomic or functional feeding group similarity between two samples. QSI values can range from 0%, when no taxa are common to the two samples, to 100% when all taxa are present in the same proportion in both samples. QSI values were usually low, indicating that benthic community composition was generally dissimilar among plains streams. In 1994, QSI-taxa values between reference streams averaged 28% and ranged from 16 to 51%. Similar results were obtained in 1993 (average 27%, range 12 to 69%). As expected from the QSI values, plains streams generally had few dominant taxa in common (Table 6). Of the 10 possible stream pairings, nine had two or less dominant taxa in common (Table 7). Using functional feeding groups, QSI values averaged 58% and ranged from 41 to 84%.

Metrics

Plains reference stream data from 1990 through 1994 were summarized for 18 potential metrics. Metric means, ranges and relative percent differences (R%Dif) are presented in Table 8. For most metrics, the 1994 data slightly reduced metric variability and moved mean values in the direction indicating higher biological integrity. Relative Percent Differences ranged from 5% for Community Tolerance Quotient (CTQa) to 119% for the % Scrapers. The CTQa was considered unacceptable as a metric because values for all plains streams were near the maximum possible value (indicating high tolerance to environmental stress) and, therefore, had little ability to discriminate between sites.

Recent bioassessments of Montana plains streams have used the first six metrics listed in Table 8. These metrics were generally less variable than other metrics tested; however, relative percent differences remained rather high, ranging from 15 to 70%. Most metrics also exhibited relatively high variability within individual reference streams (Table 9). Excessive site-specific variability reflected varying degrees of environmental stress and different sampling conditions, particularly extremes in streamflow, during the study period (McGuire 1994a).

The flow regimes of these streams probably accounted for much of the variability in benthic communities and the metrics used to characterize them. Drought and dewatering can have profound and lasting affects on macroinvertebrate assemblages. The loss of riffle habit during low and no flow conditions adversely impacts biological integrity. Taxa characteristic of riffles in healthy streams, including most mayflies, caddisflies and other sensitive species, tend to be eliminated or reduced in abundance when surface flow is absent. Metric responses to these conditions may mask more subtle impacts associated with water and habitat quality.

Drought induced impacts may be exacerbated when low flows force sample collection from standing water habitats which typically support less diverse and more tolerant benthic assemblages. According to field notes, samples were taken from marginal habitats when flowing water habitats were limited. These samples accounted for most of the extreme values in the data set. Thus, the reference stream data did not accurately represent conditions in riffle habitats. New sampling protocols for low-gradient streams (Bukantis 1995) address this problem. The "20 jab" sampling technique needs to be tested and compared with riffle samples from the same stream when ever possible. Different metrics and/or separate criteria may be required when sampling different habitats.

RBP Criteria

The reference stream data compiled from 1990 through 1994 were too variable to clearly define a unified reference or "least impaired" condition in Montana's plains ecoregions. In fact, most reference stream collections indicated impaired biointegrity when compared with criteria current used to evaluate plains streams (Table 10). Therefore, an alternate approach, incorporating 22 additional plains stream assessments (Table 4) was used to evaluate and refine criteria for the ecoregion. For each metric, predetermined percentiles from the composite database were considered as possible thresholds for defining scoring criteria. Two assumptions are implied in this analysis: 1. Most streams included in the database suffer some degree of biological impairment. 2. The least- and most-impaired sites likely to be encountered in the ecoregion are represented by extreme values within the database.

The most rigorous guidelines examined were derived from original impairment classifications of the streams. Based on previous bioassessments (Tables 4 and 10), 18% of the sites in the database were non-impaired while 11% were severely impaired. Thus, non-impaired thresholds could be defined as the 18th percentile for metrics that would increase in value under stressful conditions and the 82nd percentile for metrics that would decrease in value as stress increased. Similarly, the 11th or 89th percentile would define severely impaired metric values. Less stringent guidelines, using upper and lower quartiles (75th and 25th percentiles, respectively) were also calculated. The breakpoint between slightly and moderately impaired values was usually established half way between the non-impaired and severely impaired endpoints.

Existing criteria were compared with the endpoints derived from the composite plains ecoregion database (Table 11). For taxa richness, derived endpoints were the same as those currently in use. Criteria for EPT richness were also generally comparable with derived thresholds; although, a slightly wider scoring range was indicated. Currently used criteria were more lenient than those derived from the database for the biotic index, % collectors and % EPT while the existing criteria for % dominant taxon appeared more stringent than warranted.

Suggested revisions for RBP assessments of plains ecoregion streams are compared with current criteria in Table 12. These revisions shift scoring criteria in the directions indicated by the analysis of the composite database. This analysis was extremely helpful in furthering our understanding of metric performances in plains streams; however, the database remains too small to provide definitive scoring criteria. Therefore, criteria for the % EPT, % collectors and % dominant taxon were tempered by professional judgment to insure that they remained biologically meaningful. Table 12 also includes tentative scoring criteria for additional metrics that may be useful in the plains ecoregions. Additional data and other approaches to establishing criteria for the plains ecoregion may be available from adjacent states.

MOUNTAIN ECOREGION

During 1994, single samples were obtained from the Boulder, West Fork Stillwater, South Fork Sun and North Fork Teton rivers and from Seymour Creek. The 1994 data were compared with previous years and metric values from all four years were summarized.

Community composition

Community composition was similar among four of five mountain reference streams. Heptageniid mayflies, represented by up to five taxa, were numerically dominant in all reference streams except Seymour Creek (Table 13). The caddisfly, *Micrasema*, was the most abundant macroinvertebrate in the Seymour Creek which is the only reference site located downstream from a lake.

Faunal similarity among mountain reference streams in 1994 was quantified using three similarity indices (Table 14). The Qualitative Similarity Indices (QSI-taxa and QSI-ffg) describe taxonomic or functional feeding group similarity between two samples. QSI values can range from 0%, when no taxa are common to the two samples, to 100% when all taxa are present in the same proportion in both samples. Among the five reference streams, QSI-taxa values ranged from 73 to 31% and averaged 43%. Similar values were reported for 1993 when a cluster analysis of (McGuire 1994a) indicated relatively distinct fauna assemblages in two groups of streams: Boulder and WF Stillwater rivers in the Absaroka Mountains - NF Teton and SF Sun rivers on the east slope of the Northern Rockies. The loose geographical groupings detected in 1993 were not evident in 1994.

Metrics

Metric values have been consistent throughout the period of record and the addition of the 1994 data did not significantly change means, ranges or variability of any metric. Summary statistics for selected metrics from mountain reference streams for 1990, 1991, 1993 and 1994 are listed in Table 15. The first seven metrics in the table are currently used to assess the biological integrity of mountain streams. Overall variability of these metrics ranged from 10 to 34%. These data provide a good baseline for defining upper endpoints (nonimpaired category) for bioassessments in this ecoregion. Ten additional candidate metrics were also summarized in Table 15. Mean site-specific variation between years was less than 25% for 13 of 14 potential metrics (Table 16).

RBP Criteria

The ability of individual metrics to differentiate between impaired and nonimpaired sites was evaluated using data from reference streams and 23 additional mountain stream bioassessments (Table 3). The resulting database consisted of 41 data points for each metric. Data were grouped into three categories: non-impaired (reference streams and other non-impaired sites, n = 25), slightly impaired sites (n = 11), and moderately to severely impaired sites (n = 5). Box-and-whisker plots (means, average deviations from the mean, and ranges) were used to evaluate the performances of the seven metrics currently used to assess biological integrity in mountain streams and two additional metrics. Shannon diversity was included as a possible replacement for the % dominant taxon metric. Since several of the impaired sites were known to be polluted by metals, the metals tolerance index was also examined.

All nine metrics exhibited the expected responses and general patterns from nonimpaired to impaired sites (Figures 2 through 10). Seven metrics clearly differentiated between non-impaired and moderately/severely impaired sites. The percent relative abundance of the dominant taxon (Figure 8) and Shannon diversity (Figure 9) showed some overlap between non-impaired sites and moderately/severely impaired sites. Values of each metric except EPT richness (Figure 3) overlapped between non-impaired and slightly impaired sites. Since individual metrics respond to different types and degrees of pollution, a wide range of values, including "non-impaired" values, should be expected at slightly impaired sites. In most cases, the metrics and scoring criteria currently in use will discriminate between non-impaired and impaired sites. When combined in an integrated assessment, they should provide a quantitative estimate of biological integrity and a useful diagnosis of the cause(s) of degradation.

ARMSTRONG SPRING CREEK

RBP samples were collected from Armstrong Spring Creek in 1990, 1991, 1993 and 1994. Selected metric values for the four years are presented in Table 17. Results have been quite consistent and metric variability between years was low. These data may serve as a baseline for evaluating impacts in other spring creeks in the plains and foothills ecoregion.

Table 1. Montana reference streams sampled in 1994.

Ecoregion	Stream	Tributary of	General location	Sampling location	Years sampled
Northern Rockies (#15)					
	Seymour Cr.	Big Hole R.	Anaconda Range	T3N R13W Sec 9	90,91,93,94
	S. F. Sun R.	Sun R.	Lewis & Clark Co.	T20N R10W Sec 8	90,91,93,94
	N. F. Teton R.	Teton R.	Teton Co.	T25N R9W Sec 16	93,94
Middle Rockies (#17)					
	W. F. Stillwater R.	Stillwater R.	Sweet Grass Co.	T5S R14E Sec 14	90,91,93,94
	Boulder R.	Yellowstone R.	Sweet Grass Co.	T6S R12E Sec 28	90,91,93,94
Northern Montana Glaciated Plains (#41)					
	Rock Cr. nr. Hinsdale	Milk R.	Valley Co.	T36N R3E Sec 8	90,91,93,94
	Battle Creek	Milk R.	Blaine Co.	T33N R19E Sec 3	93,94
	Woody Island Coulee	Cottonwood C.	Blaine Co.	Hiway 241 bridge	92,94
Northwestern Great Plains (#43)					
	W. F. Poplar R.	Poplar R.	Daniels Co.	T32N R48E Sec 2	90,91,93,94
	Redwater R.	Missouri R.	McCone Co.	T25N R50E Sec 23	90,91,93,94
Montana Valley & Foothill Prairies (#16)					
	Armstrong Spring Cr.	Yellowstone R.	Park Co.	T3S R9E Sec 26	90,91,93,94

Table 2. Metrics used to characterize aquatic macroinvertebrate assemblages in Montana reference streams.

Metric	Reference
Community structure	
* Taxa richness	Plafkin et al. (1989)
* EPT richness	Plafkin et al. (1989)
Shannon diversity	Weber (1973)
* % dominant taxon	Plafkin et al. (1989)
Indicator organisms	
* Biotic index	Hillsenhoff (1989)
Community Tolerance Quotient (BCI)	Winget and Mangum (1979)
Metals tolerance index	McGuire (1993)
% Chironomidae	
* % EPT	
EPT/EPTC	Plafkin et al. (1989)
% by Orders (Ephemeroptera, Plecoptera, Trichoptera, etc.)	
% Baetidae of Ephemeroptera	
* % Hydropsychinae of Trichoptera	
Voltinism (% semivoltine, % multivoltine, % univoltine)	Wisseman (1992)
Similarity Indices	
Dominants in common (DIC-5)	Shackleford (1988)
Qualitative Similarity Index (QSI-taxa)	Shackleford (1988)
Qualitative Similarity Index (QSI-FFG)	Shackleford (1988)
Community function	
% Collector-gatherers	Wisseman (1992)
% Collector-filterers	
* % Collectors - (gatherers + filterers)	McGuire (1994b)
% Shredders	Plafkin et al. (1989)
% Scrapers	
* % Scrapers + Shredders	McGuire (1994b)
Scrapers/(Scrapers + Filterers)	Plafkin et al. (1989)
% Predators	
# Collector-gatherer taxa	
# Collector-filterer taxa	
# Shredder taxa	
# Scraper taxa	
# Predator taxa	

* metrics currently used in Montana RBP assessments.

Table 3. Mountain ecoregion streams used to evaluate metric performance.

Reference streams	data source
Boulder River	this report
WF Stillwater River	this report
Seymour Creek	this report
SF Sun River	this report
NF Teton River	this report

other nonimpaired streams	data source
Dry Creek	McGuire 1994b
Tobacco River	McGuire 1994b
Snowshoe Creek reach 2	McGuire 1994b
Keeler Creek	McGuire 1994b
WF Rock Creek reach 1	McGuire 1994b
Rock Creek	McGuire 1994b
S. Willow Creek	McGuire 1995a

slightly impaired streams	
Elkhorn Creek	McGuire 1994b
Snowshoe Creek reach 1	McGuire 1994b
WF Rock Creek reach 3	McGuire 1994b
Soda Butte Creek reach 1	McGuire 1995b
Soda Butte Creek reach 2	McGuire 1995b
Soda Butte Creek reach 3	McGuire 1995b
Soda Butte Creek reach 4	McGuire 1995b
Rebublic Cr.	McGuire 1995b
Birch Cr.	McGuire 1995c
Basin Cr.	McGuire 1995c
S. Boulder River	McGuire 1995a

moderately and severely impaired streams	
Wolf Creek	McGuire 1994b
Fisher Creek	McGuire 1994c
Crow Creek	McGuire 1995c
Beaver Creek	McGuire 1995c
Wise River	McGuire 1995c

Table 4. Plains ecoregion streams used to evaluate metric performance.

stream	year sampled	data source*	classification
WF Poplar River	90,91,93,94	1	Table 10
WF Poplar R. (2nd order)	91	2	Table 10
Redwater River	90,91,93,94	1	Table 10
Rock Creek	90,91,93,94	1	Table 10
Battle Creek	93, 94	1	Table 10
Woody Island Coulee	92, 94	1, 3	Table 10
Armells Creek	92	3	moderate
Little Dry Creek	92	3	severe
Musselshell River 2	92	3	mod/sev
Musselshell River 1	92	3	severe
Little Powder River	92	3	slight
Mizpah Creek	92	3	moderate
Little Porcupine River	92	3	moderate
Big Porcupine River	92	3	slight
Sage Creek	93	4	moderate
Battle Creek	93	4	moderate
Careless Creek	94	5	non-impaired
Yellow Water Creek	94	5	sli/mod
Flatwillow Creek	94	5	moderate
Big Coulee	94	5	non-impaired
Coffee Creek	94	5	severe
Arrow Creek	94	5	non-impaired
Wolf Creek	94	5	slight
Dry Wolf Creek	94	5	moderate
Dog Creek	94	5	moderate
Nelson Creek	94	5	moderate
Timber Creek	94	5	moderate

* 1= this report, 2 = McGuire 1993, 3= McGuire 1994b, 4 = McGuire 1995a, 5= McGuire 1995c.

Table 5. Mean relative abundances (%) of the 10 most abundant taxa during four years of monitoring in Montana Plains Reference Streams.

1990	1991	1993	1994
Simulium (21)	Cheumatopsyche (38)	Simulium . (36)	Cheumatopsyche (17)
Coenagrionidae (14)	Tanytarsus (17)	Cheumatopsyche (13)	Simulium (13)
Micropsectra (8)	Simulium (12)	Ceratopsyche (11)	Gammarus (11)
Dicrotendipes (7)	Hyalella (8)	Tricorythodes (8)	Rheotanytarsus (9)
Caenis (5)	Corixidae (5)	Hyalella (5)	Ceratopsyche (9)
Paratanytarsus (5)	Isonychia (5)	Leucrocuta (5)	Ithytrichia (9)
Hyalella (5)	Baetis (4)	Corixidae (4)	Leucrocuta (6)
Oligochaeta (4)	Cricotopus (3)	Baetis (4)	Tricorythodes (4)
Endochironomus (3)	Caenis (2)	Ablabesmyia (2)	Corixidae (2)
Corixidae (3)	Gammarus (2)	Caenis (2)	Baetis (2)

Table 6. Relative abundances (%) of the five most abundant taxa in five plains references streams during 1994.

WF Poplar R.	Redwater R.	Rock Cr.	Battle Cr.	Woody Island C.
Leucrocuta (26)	Ithytrichia (42)	Cheumatopsyche (30)	Ceratopsyche (27)	Gammarus (39)
Tricorythodes (21)	Cheumatopsyche (24)	Rheotanytarsus (23)	Simulium (22)	Simulium (32)
Gammarus (14)	Ceratopsyche (14)	Caenis (8)	Cheumatopsyche (19)	Rheotanytarsus (9)
Acentrella (7)	Simulium (8)	Paratanytarsus (8)	Rheotanytarsus (6)	Hyalella (4)
Isonychia (5)	Rheotanytarsus (5)	Ablabesmyia (5)	Baetis (6)	Helicopsyche (3) Optioservus (3)

Table 7. Similarity indice values for plains reference streams in 1994.

Index				
QSI-taxa	WF Poplar	Redwater	Rock	Battle
Redwater R.	16			
Rock Cr.	17	41		
Battle Cr.	23	51	36	
Woody Island	23	16	22	33
QSI-ffg	WF Poplar	Redwater	Rock	Battle
Redwater R.	51			
Rock Cr.	55	60		
Battle Cr.	41	60	84	
Woody Island	54	50	64	59
DIC-5	WF Poplar	Redwater	Rock	Battle
Redwater R.	0			
Rock Cr.	0	2		
Battle Cr.	0	4	2	
Woody Island	1	2	1	2

Table 8. Summary of metric values for plains reference streams in Montana.

METRIC	MEANS 1990	1991	1993	1994	all	min	max	Ave Dev	R%Dif
n=	3	3	4	5	16*				
Taxa richness	23	18	16	22	20	11	35	5	27%
EPT richness	4	5	7	7	6	1	11	3	43%
Biotic index	7.1	5.7	5.4	5.0	5.7	3.6	7.5	0.8	15%
% dominant	34	54	53	33	42	14	78	14	33%
Shannon diversity	3.2	2.3	2.3	3.0	2.7	1.4	4.2	0.5	19%
% Chironomidae	38	26	8	17	19	1	65	17	88%
HBI-CTQa	103	100		100	101	86	107	5	5%
% EPT	12	43	45	52	39	3	85	27	70%
EPT/EPTC	0.30	0.66	0.74	0.68	0.63	0.13	0.96	0.29	46%
% multivoltine	63	45	57	40	47	1	85	19	40%
# predator taxa	7	4	3	5	5	2	11	2	33%
% Collector-gatherer	45	33	24	19	29	4	72	18	63%
% Collector-filterer	28	48	62	49	45	2	88	28	61%
% Collector (G+F)	73	81	86	68	74	44	99	15	20%
% Scraper	0	2	6	16	8	0	42	9	119%
% Shredder	8	10	2	11	10	0	39	10	104%
% Scraper+Shredder	9	12	7	27	17	0	51	16	95%
Scraper/(Scrap+Filt.)	0.01	0.08	0.15	0.24	0.19	0.00	0.88	0.22	118%

* includes data from Woody Isle Coulee 9/19/92.

Table 9. Metric values and variability in Plains ecoregion reference streams, 1990-94.

Metric	STREAM					Mean	Metric	STREAM					Mean
	WF Pop	Rwater	Rock	Battle	Wood Is	R%Dif		WF Pop	Rwater	Rock	Battle	Wood Is	R%Dif
Taxa richness							EPT richness						
1990	24	11	35				1990	7	1	4			
1991	18	13	23				1991	10	3	3			
1993	23	13	13	14	18		1993	11	6	3	7	6	
1994	23	16	27	24	21		1994	10	4	4	10	5	
AveDif	2.2	1.4	6.5	5.0	1.5		AveDif	1.2	1.5	0.5	1.5	0.5	
R%Dif	10%	10%	27%	26%	8%	16%	R%Dif	13%	43%	14%	18%	9%	19%
S. diversity							% Dominant						
1990	2.6	2.9	4.3				1990	56	31	14			
1991	2.8	1.1	2.8				1991	35	77	50			
1993	3.2	2.5	1.4	2.0	2.6		1993	34	39	78	60	35	
1994	3.3	2.4	3.3	3.2	2.6		1994	26	42	30	27	39	
AveDif	0.3	0.6	0.9	0.6	0.0		AveDif	9	15	21	17	2	
R%Dif	10%	25%	29%	24%	0%	18%	R%Dif	24%	31%	49%	38%	5%	30%
% Chironomidae							EPT/EPTC						
1990	12	48	53				1990	0.62	0.14	0.13			
1991	1	12	65				1991	0.96	0.87	0.16			
1993	7	11	7	5	1		1993	0.92	0.86	0.31	0.85	0.91	
1994	6	8	47	11	14		1994	0.92	0.91	0.47	0.85	0.26	
AveDif	3	14	18	3	6		AveDif	0.12	0.28	0.12	0.00	0.33	
R%Dif	46%	72%	42%	38%	85%	56%	R%Dif	14%	40%	46%	0%	56%	31%
Biotic index							% EPT						
1990	6.7	7.5	7.2				1990	18	8	10			
1991	6.0	5.2	6.1				1991	33	85	12			
1993	4.0	5.4	7.1	5.3	5.9		1993	78	69	3	30	11	
1994	3.6	4.6	5.8	5.5	5.5		1994	70	82	42	62	5	
AveDif	1.3	0.9	0.6	0.1	0.2		AveDif	24	27	13	16	3	
R%Dif	25%	16%	9%	3%	4%	11%	R%Dif	49%	43%	75%	35%	38%	48%

Table 9. Metric values and variability in Plains ecoregion reference streams, 1990-94.

Metric	STREAM					Mean	Metric	STREAM					Mean
	WF Pop	Rwater	Rock	Battle	Wood Is	R%Dif		WF Pop	Rwater	Rock	Battle	Wood Is	R%Dif
% Collectors-gatherers							% Scrapers						
1990	14	62	60				1990	1	0	0			
1991	14	14	72				1991	6	0	1			
1993	51	18	12	15	42		1993	19	0	2	1	16	
1994	34	4	26	17	12		1994	27	42	3	3	3	
AveDif	14	19	24	1	15		AveDif	10	16	1	1	7	
R%Dif	50%	77%	55%	6%	56%	49%	R%Dif	74%	150%	67%	50%	68%	82%
% Collectors (g + f)							% Scrapers + Shredders						
1990	85	64	71				1990	8	8	10			
1991	65	98	78				1991	35	0	2			
1993	68	84	91	98	44		1993	24	0	3	1	51	
1994	52	56	86	93	53		1994	42	42	5	3	42	
AveDif	9	16	7	3	5		AveDif	11	15	3	1	5	
R%Dif	13%	21%	9%	3%	9%	11%	R%Dif	41%	118%	50%	50%	10%	54%
# Predator taxa							% Multivoltine						
1990	6	3	11				1990	78	48	64			
1991	3	4	4				1991	48	16	70			
1993	4	3	3	2	6		1993	58	15	85	69	1	
1994	4	4	5	5	7		1994	38	18	53	44	46	
AveDif	1	1	3	2	1		AveDif	13	12	10	13	22	
R%Dif	21%	14%	46%	43%	8%	26%	R%Dif	23%	49%	14%	22%	95%	41%

Table 10. Bioassessment scores (%) and impairment classifications for plains reference streams.

stream	1990	1991	1992	1993	1994	mean
WF Poplar R.	47 (moderate)	75 (slight)		89 (non)	94 (non)	76 (slight)
WF Poplar R. (2nd order)		67 (slight)				
Redwater R.	33 (moderate)	39 (moderate)		72 (slight)	67 (slight)	53 (slight/mod)
Rock Cr.	61 (slight)	44 (moderate)		17 (severe)	72 (slight)	49 (moderate)
Battle Cr.				44 (moderate)	83 (non)	64 (slight)
Woody Island C.			81 (non/slight)		78 (slight)	80 (non/slight)
mean	47 (moderate)	56 (slight)		56 (slight)	79 (slight)	63 (slight)

Table 11. Summary of metric values in Montana plains ecoregion streams (n=38) and existing scoring criteria for the ecoregion.

				Quartiles			Percentiles		current criteria *			
metric	mean	min	max	1st	2nd	3rd	11%/89%	18%/82%	nonimpaired	slight	moderate	severe
Taxa richness	18	4	35	13	17	23	11	24	>24	24 -18	18-12	<12
EPT richness	5	0	11	3	4	7	2	8	>7	7 - 6	5 - 4	<4
Biotic index	6.0	2.9	7.9	5.2	5.9	6.9	7.2	5.1	<6	6 - 7	7 - 8	>8
% Dominant taxon	47	14	94	34	42	64	78	29	<30	30 - 40	40 - 50	>50
% Collectors (g+f)	77	23	100	63	82	92	98	58	<70	70 - 85	85 - 95	>95
%EPT	41	0	98	11	33	69	2	78	>35	35 - 20	20 - 5	<5
S. Diversity	2.5	0.4	4.2	1.8	2.6	3.1	1.4	3.3				
% Scrapers+shredders	12	0	67	1	4	14	0	32				
# Predator taxa	5	1	11	3	4	6	2	6				
% Multivoltine	37	1	99	16	32	57	77	10				

* McGuire 1995a

Table 12. RBP assessment criteria for plains ecoregion streams: existing criteria, suggested revisions and preliminary criteria for experimental metrics.

	current criteria				revised criteria			
metric	non-impaired	slight	moderate	severe	non-impaired	slight	moderate	severe
Taxa richness	>24	24 -18	18-12	<12	>24	24 -18	18-12	<12
EPT richness	>7	7 - 6	5 - 4	<4	>8	8 - 6	5 - 3	<3
Biotic index	<6	6 - 7	7 - 8	>8	<5	5 - 6	6 - 7	>7
% Dominant taxon	<30	30 - 40	40 - 50	>50	<30	30 - 45	45 - 60	>60
% Collectors (g+f)	<70	70 - 85	85 - 95	>95	<60	60 - 80	80 - 95	>95
% EPT	>35	35 - 20	20 - 5	<5	>50	50 - 30	30 - 10	<10

	possible criteria			
experimental metrics	non-impaired	slight	moderate	severe
S. Diversity	>3.0	3.0-2.4	2.4-1.8	<1.8
% Scrapers+shredders	>30	30-15	15-3	<3
# Predator taxa	>5	4 - 5	3 - 4	<3
% Multivoltine	<40	40-60	60-80	>80

Table 13. Relative abundances (%) of the five most abundant taxa in five mountain references streams during 1994.

Boulder R.	WF Stillwater R.	Seymour Cr.	SF Sun R.	NF Teton R.
Cinygmula (19)	Cinygmula (26)	Micrasema (15)	Epeorus deceptivus (16)	Epeorus deceptivus (42)
Cricotopus nostoc. (14)	Epeorus deceptivus (26)	Tvetenia (9)	Tvetenia (16)	Cinygmula (25)
Serratella (12)	Drunella coloradensis (11)	Zapada oregenensis (8)	Drunella doddsi (13)	Zapada oregenensis (5)
Ameletus (8)	Baetis tricaudatus (6)	Serratella (6)	Epeorus longimanus (10)	Drunella coloradensis (4)
Epeorus longimanus (8)	Micropsectra (5)	Epeorus deceptivus (6)	Serratella (6)	Tvetenia (4)

Table 14. Similarity indice values for mountain reference streams in 1994.

QSI-taxa	Boulder	WF Stillw	Seymour	SF Sun
WF Stillwater	50			
Seymour Cr	36	31		
SF Sun	38	45	43	
NF Teton	38	73	33	41

QSI-ffg	Boulder	WF Stillw	Seymour	SF Sun
WF Stillwater	62			
Seymour Cr	77	43		
SF Sun	83	74	63	
NF Teton	58	91	38	66

DIC-5	Boulder	WF Stillw	Seymour	SF Sun
WF Stillwater	1			
Seymour Cr	1	1		
SF Sun	2	1	3	
NF Teton	1	3	3	2

Table 15. Summary of metric values for mountain reference streams in Montana.

	MEANS								
METRIC	1990	1991	1993	1994	all	min	max	Ave Dev	R%Dif
n=	4	4	5	5	18				
Taxa richness	35	30	33	33	33	24	45	4	13%
EPT richness	23	22	21	21	22	16	29	3	13%
Biotic index	2.0	1.4	1.2	1.7	1.5	0.5	2.7	0.5	34%
% dominant	24	26	33	24	27	11	42	8	31%
% Collector (G+F)	31	28	36	30	32	13	50	10	32%
% Scraper+Shredder	60	65	54	60	59	40	84	12	21%
% EPT	86	91	88	77	85	68	97	9	10%
Shannon diversity	4.0	3.5	3.3	3.8	3.6	2.8	4.8	0.5	14%
% Chironomidae	12	5	10	20	12	1	29	8	66%
EPT/EPTC	0.88	0.95	0.90	0.79	0.88	0.70	0.99	0.08	9%
CTQa (BCI)	50	34		44	43	25	57	8	18%
Melals tolerance index			1.5	1.6	1.6	0.5	3.0	0.7	45%
% Collector-gatherer	27	19	34	29	28	12	43	10	35%
% Collector-filterer	4	9	2	1	4	0	17	4	100%
% Scraper	56	60	52	50	54	16	79	14	26%
% Shredder	4	5	2	10	5	0	25	4	80%
# Predator taxa	9	9	11	10	10	6	16	2	23%

Table 16. Metric values and variability in mountain ecoregion reference streams over four years.

Metric	STREAM					Mean	Metric	STREAM					Mean
	Bould	WF St	SF Su	Seym	NF Tet	R%Dif		Bould	WF Stw	SF Sun	Seym	NF Tet	R%Dif
Taxa richness							EPT richness						
1990	30	29	36	44			1990	23	20	24	25		
1991	28	24	32	37			1991	19	18	23	29		
1993	30	31	34	35	25		1993	20	22	22	22	16	
1994	33	30	32	45	27		1994	22	17	21	29	18	
AveDif	1.4	2.3	1.5	4.3	1.0		AveDif	1.5	1.8	1.0	2.8	1.0	
R%Dif	5%	8%	4%	11%	4%	6%	R%Dif	7%	9%	4%	10%	6%	7%
Biotic Index							# Predator taxa						
1990	1.7	1.6	2.0	2.7			1990	7	8	9	10		
1991	1.8	1.0	1.2	1.5			1991	6	8	8	13		
1993	1.0	0.9	2.1	1.3	0.5		1993	10	13	11	14	7	
1994	2.0	1.0	2.5	2.3	0.8		1994	10	7	10	16	7	
AveDif	0.3	0.2	0.4	0.5	0.2		AveDif	2	2	1	2	0	
R%Dif	19%	21%	19%	28%	27%	23%	R%Dif	21%	22%	11%	13%	0%	13%
S. diversity							% Dominant						
1990	3.6	3.3	4.1	4.8			1990	26	35	23	11		
1991	3.3	2.8	3.5	4.5			1991	30	36	24	15		
1993	3.3	3.3	3.8	3.4	2.8		1993	41	36	19	30	38	
1994	4.0	3.4	3.9	4.7	2.9		1994	19	26	16	15	42	
AveDif	0.2	0.2	0.2	0.5	0.1		AveDif	7	4	3	6	2	
R%Dif	7%	6%	5%	11%	2%	6%	R%Dif	22%	11%	15%	35%	5%	17%
% Chironomidae							% EPT						
1990	2	6	13	26			1990	97	92	85	69		
1991	5	1	2	10			1991	93	97	94	81		
1993	8	5	23	8	4		1993	90	92	74	88	95	
1994	24	11	29	24	11		1994	72	86	68	68	89	
AveDif	7	3	9	8	4		AveDif	8	3	9	8	3	
R%Dif	73%	48%	55%	47%	47%	54%	R%Dif	9%	3%	12%	10%	3%	7%

Table 16. Metric values and variability in mountain ecoregion reference streams over four years.

Metric	STREAM					Mean	Metric	STREAM					Mean
	Bould	WF St	SF Su	Seym	NF Tet	R%Dif		Bould	WF Stw	SF Sun	Seym	NF Tet	R%Dif
% Collectors-gatherers							% Scrapers						
1990	27	19	25	41			1990	60	53	54	33		
1991	36	17	12	23			1991	47	71	74	44		
1993	34	39	43	43	13		1993	52	48	49	40	72	
1994	37	18	41	36	12		1994	37	72	48	16	79	
AveDif	3	8	12	6	1		AveDif	7	11	9	9	4	
R%Dif	10%	34%	39%	18%	4%	21%	R%Dif	14%	17%	16%	26%	5%	16%
% Collectors (g + f)							% Scrapers + Shredders						
1990	28	20	28	53			1990	61	59	60	39		
1991	39	18	14	37			1991	50	72	75	49		
1993	34	40	44	48	14		1993	54	49	49	42	78	
1994	37	20	43	39	13		1994	53	74	49	40	84	
AveDif	4	8	11	6	1		AveDif	3	10	9	3	3	
R%Dif	10%	32%	35%	14%	4%	19%	R%Dif	6%	15%	16%	8%	4%	10%
Metals Tolerance index							CTQa						
1990							1990	45	45	51	57		
1991							1991	43	31	25	38		
1993	1.0	1.1	3.0	1.8	0.5		1993						
1994	1.9	0.9	2.1	2.5	0.8		1994	51	37	50	51	32	
AveDif	0.5	0.1	0.5	0.4	0.1		AveDif	3	5	11	7		
R%Dif	31%	10%	19%	17%	22%	20%	R%Dif	7%	13%	27%	15%		15%

TABLE 17. Selected metrics characterizing the biological integrity in Armstrong Spring Creek during 1990, 1991, 1993 and 1994.

Metric	1990*	1991	1993	1994	Mean	Ave Dev	R%Dif
Taxa richness	20	19	22	22	21	1.3	6%
EPT richness	5	3	4	5	4	0.8	18%
Biotic index	5.3	5.7	4.8	4.5	5.1	0.4	9%
% RA dominant taxon	20	22	34	40	29	8.0	28%
Shannon diversity	3.2	3.3	3.3	3.0	3.2	0.1	3%
%Baetidae-Ephemeroptera	100	85	96	100	95	5.1	5%
% Chironomidae	39	65	35	21	40	12.5	31%
% EPT	33	4	37	45	30	12.9	43%
EPT/ EPTC	0.46	0.06	0.52	0.68	0.43	0.19	43%
% RA Scrapers	15	10	9	9	11	2.1	20%
% RA Collector-gatherers	76	67	62	70	69	4.3	6%
% Scrapers + Shredders	17	14	15	11	14	1.8	12%
% Collectors (g+f)	78	68	69	72	72	3.3	5%

*adapted from Wisseman 1992 (to ~ 300 organisms).

Figure 1. Mean relative abundances (%) of major macroinvertebrate groups in Plains reference streams.

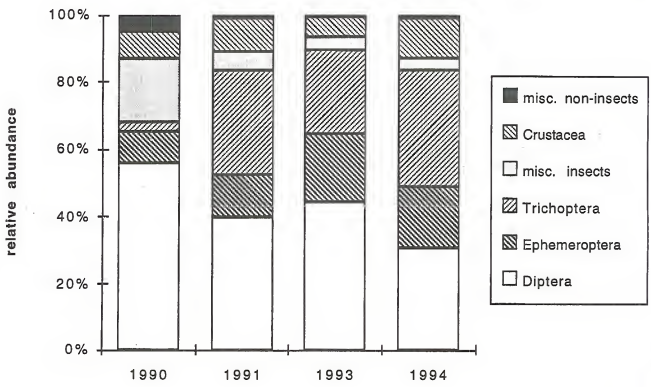


Figure 2. Taxa richness in three categories of mountain streams.

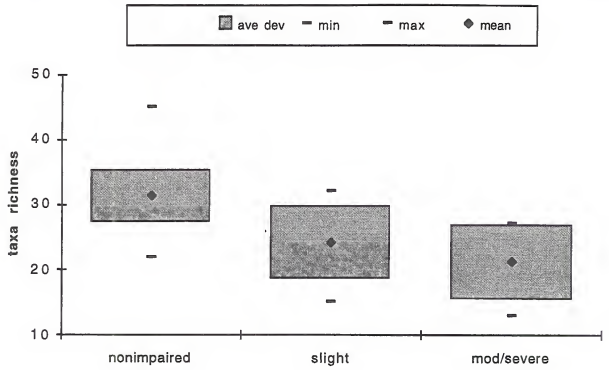


Figure 3. EPT richness in three categories of mountain streams.

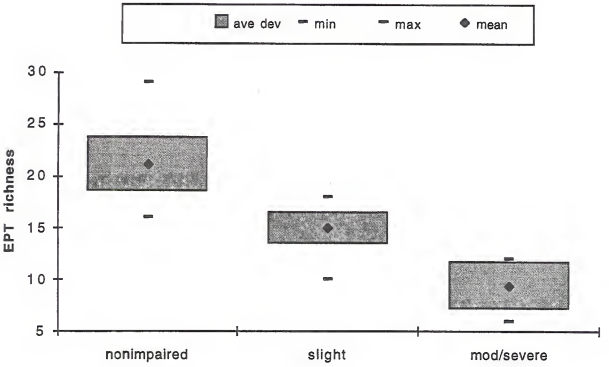


Figure 4. Biotic index values in three categories of mountain streams.

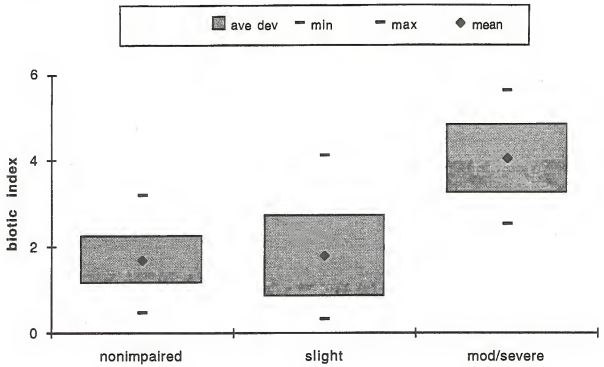


Figure 5. EPT relative abundance in three categories of mountain streams.

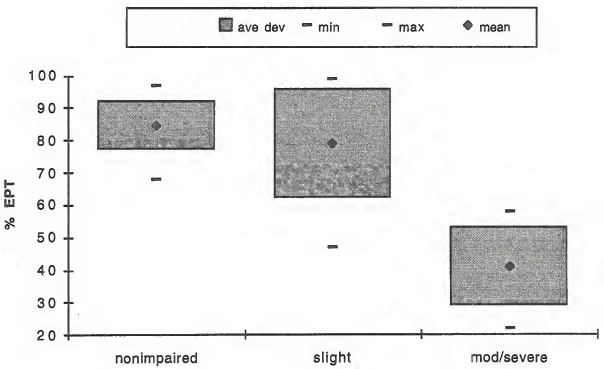


Figure 6. Collector (gatherer + filterer) relative abundance in three categories of mountain streams.

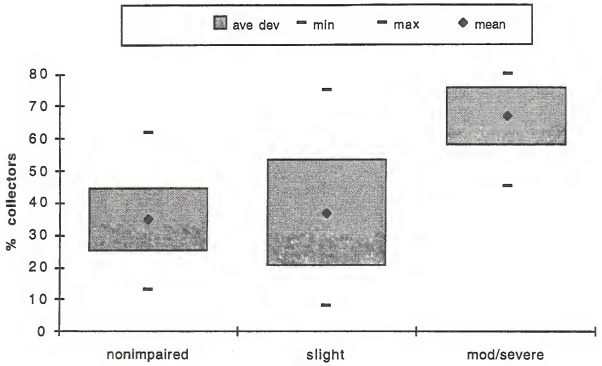


Figure 7. Scraper + shredder relative abundance in three categories of mountain streams.

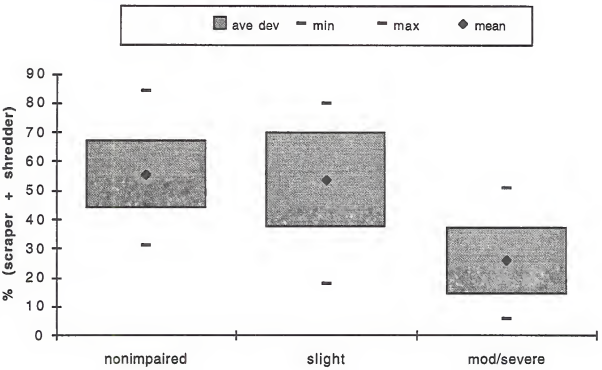


Figure 8. Relative abundance of the dominant taxon in three categories of mountain streams.

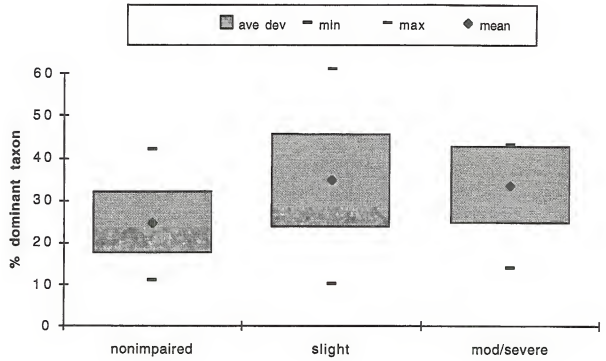


Figure 9. Shannon diversity values in three categories of mountain streams.

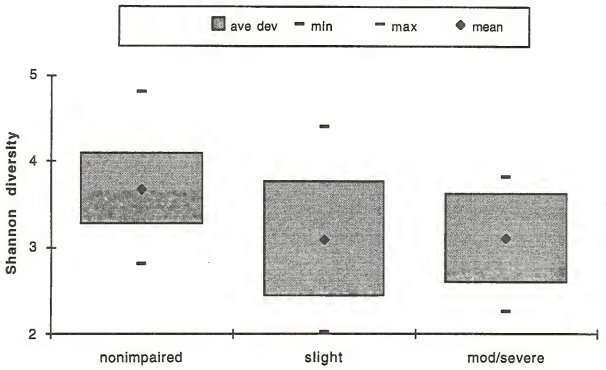
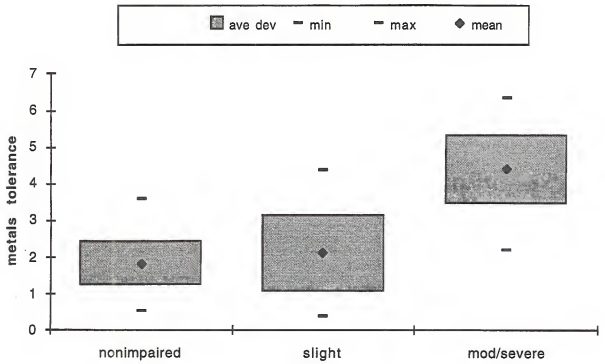


Figure 10. Metals tolerance values in three categories of mountain streams.



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APPENDIX A:

AQUATIC MACROINVERTEBRATE DATA
MONTANA REFERENCE STREAMS

1994

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Boulder R @ reference site - July 19, 1994

Taxon	300 organism subsample	% relative abundance
DIPTERA		
Diamesa sp.	1	0.3%
Pagastia sp.	9	2.8%
Cricotopus sp.	2	0.6%
Cricotopus nostococladius	43	13.5%
Eukiefferiella spp.	2	0.6%
Orthocladius sp.	2	0.6%
Rheocricotopus sp.	1	0.3%
Tvetenia sp.	1	0.3%
Micropsectra sp.	16	5.0%
Hexatoma sp.	2	0.6%
EPHEMEROPTERA		
Baetis tricaudatus	15	4.7%
Baetis bicaudatus	1	0.3%
Caudatella hystrix	1	0.3%
Drunella coloradensis	6	1.9%
Drunella doddsi	4	1.3%
Drunella spinifera	2	0.6%
Ephemerella infrequens	2	0.6%
Serratella sp.	39	12.3%
Cinygmula sp.	60	18.9%
Epeorus deceptivus	15	4.7%
Epeorus longimanus	24	7.5%
Rhithrogena sp.	9	2.8%
Ameletus sp.	26	8.2%
PLECOPTERA		
Chloroperlinae	2	0.6%
Zapada oregenensis gp.	6	1.9%
Hesperoperla pacifica	1	0.3%
Doroneuria sp.	1	0.3%
Kogotus sp.	2	0.6%
TRICHOPTERA		
Glossosoma sp.	1	0.3%
Rhyacophila alberta gp.	3	0.9%
Rhyacophila brunnea gp.	8	2.5%
Rhyacophila sibirica gp.	2	0.6%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Boulder R @ reference site - July 19, 1994

Taxon	300 organism subsample	% relative abundance
OTHER		
Turbellaria	9	2.8%

IDs by D. McGuire	5/16 ths of sample used	
TOTAL ORGANISMS	318	
TAXA RICHNESS	33	
EPT RICHNESS	22	
BIOTIC INDEX	2.02	
% DOMINANT TAXON	19%	
% EPT	72%	
% COLLECTORS (g+f)	37%	
% SCRAPERS + SHREDDERS	53%	
% Hydropsychinae of TRICH	0%	
METALS TOLERANCE INDEX	1.94	
% Baetidae of EPHEM.	8%	
SHANNON DIVERSITY	3.98	
EPT/(EPT + Chironomidae)	0.75	
HBI- CTQa	51	
% COLEOPTERA	0%	
% DIPTERA	25%	
% CHIRONOMIDAE	24%	
% EPHEMEROPTERA	64%	
% PLECOPTERA	4%	
% TRICHOPTERA	4%	
% multivoltine	32%	
% univoltine	68%	
% semivoltine	1%	
FFG	% RA	# of taxa
% FILTERERS	0%	0
% COLLECTOR-GATHERERS	37%	14
% SHREDDERS	15%	2
% SCRAPERS	37%	7
% PREDATORS	10%	10
Scraper/(Scraper+Filterer)	100%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
West Fork Stillwater River @ reference site - July 20, 1994

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Heterlimnius sp.	1	0.3%
DIPTERA		
Pagastia sp.	2	0.6%
Cricotopus sp.	1	0.3%
Eukiefferiella spp.	3	0.9%
Thienemanniella sp.	1	0.3%
Tvetenia sp.	10	3.0%
Micropsectra sp.	17	5.1%
Rheotanytarsus sp.	1	0.3%
Hexatoma sp.	4	1.2%
Chelifera sp.	1	0.3%
Ceratopogoninae	2	0.6%
Prosimulium sp.	1	0.3%
EPHEMEROPTERA		
Baetis tricaudatus	19	5.7%
Baetis bicaudatus	4	1.2%
Drunella coloradensis	38	11.4%
Drunella doddsi	8	2.4%
Serratella sp.	1	0.3%
Cinygmula sp.	85	25.6%
Epeorus deceptivus	85	25.6%
Epeorus longimanus	14	4.2%
Rhithrogena sp.	8	2.4%
Ameletus sp.	1	0.3%
PLECOPTERA		
Zapada oregenensis gp.	8	2.4%
Megarcys sp.	5	1.5%
TRICHOPTERA		
Parapsyche sp.	4	1.2%
Glossosoma sp.	1	0.3%
Rhyacophila betteni gp.	3	0.9%
Rhyacophila brunnea gp.	1	0.3%
Rhyacophila sibirica gp.	2	0.6%
ANNELIDA		
Enchytraeidae	1	0.3%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
West Fork Stillwater River @ reference site - July 20, 1994

Taxon	300 organism subsample	% relative abundance
IDs by D. McGuire	2/8ths of sample used	
TOTAL ORGANISMS	332	
TAXA RICHNESS	30	
EPT RICHNESS	17	
BIOTIC INDEX	1.00	
% DOMINANT TAXON	26%	
% EPT	86%	
% COLLECTORS (g+f)	20%	
% SCRAPERS + SHREDDERS	74%	
% Hydropsychinae of TRICH	0%	
METALS TOLERANCE INDEX	0.89	
% Baetidae of EPHEM.	9%	
SHANNON DIVERSITY	3.41	
EPT/(EPT + Chironomidae)	0.89	
HBI- CTQa	37	
% COLEOPTERA	0%	
% DIPTERA	13%	
% CHIRONOMIDAE	11%	
% EPHEMEROPTERA	79%	
% PLECOPTERA	4%	
% TRICHOPTERA	3%	
% multivoltine	17%	
% univoltine	82%	
% semivoltine	1%	
FFG	% RA	# of taxa
% FILTERERS	2%	3
% COLLECTOR-GATHERERS	18%	12
% SHREDDERS	2%	1
% SCRAPERS	72%	7
% PREDATORS	5%	7
Scraper/(Scraper+Filterer)	98%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Seymour Creek @ reference site
3-Aug-94

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Heterlimnius sp.	7	2.3%
DIPTERA		
Thienemannimyia gp.	2	0.7%
Pagastia sp.	9	3.0%
Brillia sp.	2	0.7%
Eukiefferiella spp.	16	5.3%
Orthocladius sp.	3	1.0%
Parametriocnemus sp.	1	0.3%
Rheocricotopus sp.	7	2.3%
Tvetenia sp.	28	9.3%
Micropsectra sp.	4	1.3%
Hexatoma sp.	1	0.3%
Chelifera sp.	4	1.3%
Hemerodromia sp.	2	0.7%
Prosimulium sp.	3	1.0%
EPHEMEROPTERA		
Baetis tricaudatus	6	2.0%
Baetis bicaudatus	7	2.3%
Drunella coloradensis	3	1.0%
Drunella doddsi	2	0.7%
Drunella spinifera	6	2.0%
Serratella sp.	17	5.6%
Cinygmula sp.	15	5.0%
Epeorus deceptivus	17	5.6%
Epeorus grandis	6	2.0%
Epeorus longimanus	2	0.7%
Ameletus sp.	2	0.7%
PLECOPTERA		
Chloroperlinae	1	0.3%
Leuctridae	2	0.7%
Zapada cinctipes	1	0.3%
Zapada oregenensis gp.	25	8.3%
Yoraperla sp.	1	0.3%
Doroneuria sp.	5	1.7%
Isoperla sp.	3	1.0%
Kogotus sp.	2	0.7%
Megarcys sp.	9	3.0%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Seymour Creek @ reference site
3-Aug-94

Taxon	300 organism subsample	% relative abundance
TRICHOPTERA		
Parapsyche sp.	4	1.3%
Dicosmoecus sp.	1	0.3%
Glossosoma sp.	1	0.3%
Micrasema sp.	44	14.6%
Rhyacophila betteni gp.	4	1.3%
Rhyacophila brunnea gp.	7	2.3%
Rhyacophila hyalinata gp.	2	0.7%
Rhyacophila sibirica gp.	4	1.3%
Rhyacophila vofixa gp.	6	2.0%
ANNELIDA		
Enchytraeidae	3	1.0%
OTHER		
Turbellaria	5	1.7%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Seymour Creek @ reference site
3-Aug-94

Taxon	300 organism subsample		% relative abundance
IDs by D. McGuire	3/8 sorted. lots of moss & CPOM		
TOTAL ORGANISMS	302		
TAXA RICHNESS	45		
EPT RICHNESS	29		
BIOTIC INDEX	2.25		
% DOMINANT TAXON	15%		
% EPT	68%		
% COLLECTORS (g+f)	39%		
% SCRAPERS + SHREDDERS	40%		
% Hydropsychinae of TRICH	0%		
METALS TOLERANCE INDEX	2.47		
% Baetidae of EPHEM.	16%		
SHANNON DIVERSITY	4.74		
EPT/(EPT + Chironomidae)	0.74		
HBI- CTQa	51		
% COLEOPTERA	2%		
% DIPTERA	27%		
% CHIRONOMIDAE	24%		
% EPHEMEROPTERA	27%		
% PLECOPTERA	16%		
% TRICHOPTERA	24%		
% multivoltine	28%		
% univoltine	68%		
% semivoltine	3%		
FFG	% RA	# of taxa	
% FILTERERS	2%	2	
% COLLECTOR-GATHERERS	36%	13	
% SHREDDERS	25%	6	
% SCRAPERS	16%	8	
% PREDATORS	21%	16	
Scraper/(Scraper+Filterer)	87%		

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
South Fork Sun River A reference site - Aug 4, 1994

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Heterlimnius sp.	2	0.7%
DIPTERA		
Pagastia sp.	1	0.3%
Eukiefferiella spp.	14	4.6%
Orthocladius sp.	18	5.9%
Paraphaenocladius sp.	2	0.7%
Tvetenia sp.	47	15.5%
Micropsectra sp.	5	1.6%
Hexatoma sp.	1	0.3%
Chelifera sp.	1	0.3%
Clinocera sp.	2	0.7%
Simulium spp. (Eusimulium)	5	1.6%
EPHEMEROPTERA		
Baetis tricaudatus	17	5.6%
Psuedocloeon sp. ?	1	0.3%
Drunella coloradensis	10	3.3%
Drunella doddsi	39	12.8%
Serratella sp.	19	6.3%
Cinygmula sp.	11	3.6%
Epeorus deceptivus	48	15.8%
Epeorus grandis	2	0.7%
Epeorus longimanus	30	9.9%
Rhithrogena sp.	2	0.7%
PLECOPTERA		
Chloroperlinae	4	1.3%
Zapada oregenensis gp.	1	0.3%
Doroneuria sp.	4	1.3%
Kogotus sp.	1	0.3%
Megarcys sp.	5	1.6%
TRICHOPTERA		
Arctopsyche sp.	1	0.3%
Brachycentrus americanus	4	1.3%
Micrasema sp.	1	0.3%
Rhyacophila angelita gp.	1	0.3%
Rhyacophila brunnea gp.	4	1.3%
Rhyacophila sibirica gp.	1	0.3%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
South Fork Sun River A reference site - Aug 4, 1994

Taxon	300 organism subsample	% relative abundance
IDs by D. McGuire	1/8th sorted	
TOTAL ORGANISMS	304	
TAXA RICHNESS	32	
EPT RICHNESS	21	
BIOTIC INDEX	2.45	
% DOMINANT TAXON	16%	
% EPT	68%	
% COLLECTORS (g+f)	43%	
% SCRAPERS + SHREDDERS	49%	
% Hydropsychinae of TRICH	0%	
METALS TOLERANCE INDEX	2.08	
% Baetidae of EPHEM.	10%	
SHANNON DIVERSITY	3.94	
EPT/(EPT + Chironomidae)	0.70	
HBI- CTQa	50	
% COLEOPTERA	1%	
% DIPTERA	32%	
% CHIRONOMIDAE	29%	
% EPHEMEROPTERA	59%	
% PLECOPTERA	5%	
% TRICHOPTERA	4%	
% multivoltine	36%	
% univoltine	63%	
% semivoltine	1%	
FFG	% RA	# of taxa
% FILTERERS	2%	2
% COLLECTOR-GATHERERS	41%	10
% SHREDDERS	1%	2
% SCRAPERS	48%	8
% PREDATORS	8%	10
Scraper/(Scraper+Filterer)	96%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
N. F. Teton River @ reference site - Aug 4, 1994

Taxon	300 organism subsample	% relative abundance
DIPTERA		
Pagastia sp.	1	0.3%
Cricotopus sp.	1	0.3%
Eukiefferiella spp.	11	3.6%
Orthocladius sp.	4	1.3%
Parametriocnemus sp.	1	0.3%
Tvetenia sp.	12	3.9%
Micropsectra sp.	2	0.7%
Hexatoma sp.	1	0.3%
Rhabdomastix sp.	1	0.3%
EPHEMEROPTERA		
Baetis bicaudatus	2	0.7%
Drunella coloradensis	12	3.9%
Drunella doddsi	6	2.0%
Cinygmula sp.	77	25.3%
Epeorus deceptivus	127	41.8%
Epeorus grandis	3	1.0%
Epeorus longimanus	9	3.0%
Rhithrogena sp.	5	1.6%
Ameletus sp.	1	0.3%
PLECOPTERA		
Chloroperlinae	2	0.7%
Capniidae	1	0.3%
Zapada oregenensis gp.	14	4.6%
Megarcys sp.	1	0.3%
TRICHOPTERA		
Parapsyche sp.	3	1.0%
Glossosoma sp.	1	0.3%
Rhyacophila betteni gp.	4	1.3%
Rhyacophila brunnea gp.	1	0.3%
Rhyacophila hyalinata gp.	1	0.3%

IDs by D. McGuire	2/8ths picked
TOTAL ORGANISMS	304
TAXA RICHNESS	27
EPT RICHNESS	18

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
N. F. Teton River @ reference site - Aug 4, 1994

Taxon	300 organism subsample		% relative abundance
BIOTIC INDEX	0.83		
% DOMINANT TAXON	42%		
% EPT	89%		
% COLLECTORS (g+f)	13%		
% SCRAPERS + SHREDDERS	84%		
% Hydropsychinae of TRICH	0%		
METALS TOLERANCE INDEX	0.80		
% Baetidae of EPHEM.	1%		
SHANNON DIVERSITY	2.87		
EPT/(EPT + Chironomidae)	0.89		
HBI- CTQa	32		
% COLEOPTERA	0%		
% DIPTERA	11%		
% CHIRONOMIDAE	11%		
% EPHEMEROPTERA	80%		
% PLECOPTERA	6%		
% TRICHOPTERA	3%		
% multivoltine	11%		
% univoltine	88%		
% semivoltine	1%		
FFG	% RA	# of taxa	
% FILTERERS	1%	1	
% COLLECTOR-GATHERERS	12%	9	
% SHREDDERS	5%	2	
% SCRAPERS	79%	8	
% PREDATORS	4%	7	
Scraper/(Scraper+Filterer)	99%		

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
West Fork Poplar River @ reference site - 6/22/94

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Gyrinus sp.	1	0.3%
DIPTERA		
Cricotopus sp.	1	0.3%
Cryptochironomus sp.	1	0.3%
Microtendipes sp.	8	2.6%
Tanytarsus sp.	1	0.3%
Rheotanytarsus sp.	9	2.9%
Simulium spp. (Psilozoa)	5	1.6%
EPHEMEROPTERA		
Acentrella insignificans	21	6.7%
Fallceon quilleri	6	1.9%
Isonychia sp.	16	5.1%
Leucrocuta sp.	81	25.9%
Tricorythodes sp.	67	21.4%
TRICHOPTERA		
Ceratopsyche spp.	13	4.2%
Cheumatopsyche spp.	12	3.8%
Hydroptila sp.	1	0.3%
Polycentropus sp.	1	0.3%
Mystacides sp.	1	0.3%
HEMIPTERA		
Corrixidae	15	4.8%
Gerris sp.	2	0.6%
MOLLUSCA		
Physidae	4	1.3%
CRUSTACEA		
Decapoda	2	0.6%
Gammarus sp.	44	14.1%
Hyalella azteca	1	0.3%

IDs by D. McGuire 7/100ths of sample used

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
West Fork Poplar River @ reference site - 6/22/94

Taxon	300 organism subsample	% relative abundance
TOTAL ORGANISMS	313	
TAXA RICHNESS	23	
EPT RICHNESS	10	
BIOTIC INDEX	3.56	
% DOMINANT TAXON	26%	
% EPT	70%	
% COLLECTORS (g+f)	52%	
% SCRAPERS + SHREDDERS	42%	
% Hydropsychinae of TRICH	89%	
METALS TOLERANCE INDEX	2.61	
% Baetidae of EPHEM.	14%	
SHANNON DIVERSITY	3.31	
EPT/(EPT + Chironomidae)	0.92	
HBI- CTQa	86	
% COLEOPTERA	0%	
% DIPTERA	8%	
% CHIRONOMIDAE	6%	
% EPHEMEROPTERA	61%	
% PLECOPTERA	0%	
% TRICHOPTERA	9%	
% multivoltine	38%	
% univoltine	61%	
% semivoltine	1%	
FFG	% RA	# of taxa
% FILTERERS	18%	6
% COLLECTOR-GATHERERS	34%	9
% SHREDDERS	15%	2
% SCRAPERS	27%	2
% PREDATORS	6%	4
Scraper/(Scraper+Filterer)	60%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Redwater River @ reference site - 6/22/94

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Gyrinus sp.	1	0.4%
DIPTERA		
Ablabesmyia sp.	1	0.4%
Corynoneura sp.	1	0.4%
Cricotopus sp.	1	0.4%
Cryptochironomus sp.	1	0.4%
Polypedilum sp.	1	0.4%
Micropsectra sp.	2	0.7%
Rheotanytarsus sp.	14	5.1%
Simulium spp. (Psilozoa)	22	8.1%
EPHEMEROPTERA		
Baetis sp.	5	1.8%
TRICHOPTERA		
Ceratopsyche spp.	37	13.6%
Cheumatopsyche spp.	66	24.3%
Ithytrichia sp.	115	42.3%
HEMIPTERA		
Corrixidae	3	1.1%
Sadula sp.	1	0.4%
CRUSTACEA		
Hyalella azteca	1	0.4%

IDs by D. McGuire	1/8th of sample used
TOTAL ORGANISMS	272
TAXA RICHNESS	16
EPT RICHNESS	4
BIOTIC INDEX	4.60
% DOMINANT TAXON	42%
% EPT	82%
% COLLECTORS (g+f)	56%
% SCRAPERS + SHREDDERS	42%
% Hydropsychinae of TRICH	47%
METALS TOLERANCE INDEX	4.01
% Baetidae of EPHEM.	100%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Redwater River @ reference site - 6/22/94

Taxon	300 organism subsample		% relative abundance
SHANNON DIVERSITY	2.39		
EPT/(EPT + Chironomidae)	0.91		
HBI- CTQa	107		
% COLEOPTERA	0%		
% DIPTERA	16%		
% CHIRONOMIDAE	8%		
% EPHEMEROPTERA	2%		
% PLECOPTERA	0%		
% TRICHOPTERA	80%		
% multivoltine	18%		
% univoltine	82%		
% semivoltine	0%		
FFG	% RA	# of taxa	
% FILTERERS	51%	4	
% COLLECTOR-GATHERERS	4%	7	
% SHREDDERS	0%	0	
% SCRAPERS	42%	1	
% PREDATORS	2%	4	
Scraper/(Scraper+Filterer)	45%		

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Rock Creek @ reference site - 6/23/94

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Dubiraphia sp.	1	0.4%
Hydrophilidae	3	1.1%
Gyrinus sp.	1	0.4%
DIPTERA		
Ablabesmyia sp.	14	5.1%
Cricotopus sp.	7	2.6%
Thienemanniella sp.	1	0.4%
Cryptochironomus sp.	1	0.4%
Dicrotendipes sp.	4	1.5%
Microtendipes sp.	1	0.4%
Polypedilum sp.	2	0.7%
Pseudochironomus sp.	1	0.4%
Robackia sp.	2	0.7%
Micropsectra sp.	2	0.7%
Paratanytarsus sp.	22	8.0%
Tanytarsus sp.	9	3.3%
Rheotanytarsus sp.	63	23.0%
Simulium spp. (Psilozoa)	12	4.4%
EPHEMEROPTERA		
Baetis sp.	4	1.5%
Caenis sp.	23	8.4%
TRICHOPTERA		
Cheumatopsyche spp.	82	29.9%
Ithytrichia sp.	5	1.8%
HEMIPTERA		
Corrixidae	5	1.8%
ANNELIDA		
Erpobdellidae	1	0.4%
MOLLUSCA		
Planorbiidae	1	0.4%
Physidae	1	0.4%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Rock Creek @ reference site - 6/23/94

Taxon	300 organism subsample	% relative abundance
CRUSTACEA		
Decapoda	1	0.4%
Gammarus sp.	5	1.8%

IDs by D. McGuire	5/8th of sample used	
TOTAL ORGANISMS	274	
TAXA RICHNESS	27	
EPT RICHNESS	4	
BIOTIC INDEX	5.83	
% DOMINANT TAXON	30%	
% EPT	42%	
% COLLECTORS (g+f)	86%	
% SCRAPERS + SHREDDERS	5%	
% Hydropsychinae of TRICH	94%	
METALS TOLERANCE INDEX	3.47	
% Baetidae of EPHEM.	15%	
SHANNON DIVERSITY	3.33	
EPT/(EPT + Chironomidae)	0.47	
HBI- CTQa	104	
% COLEOPTERA	2%	
% DIPTERA	51%	
% CHIRONOMIDAE	47%	
% EPHEMEROPTERA	10%	
% PLECOPTERA	0%	
% TRICHOPTERA	32%	
% multivoltine	53%	
% univoltine	47%	
% semivoltine	0%	
FFG	% RA	# of taxa
% FILTERERS	61%	4
% COLLECTOR-GATHERERS	26%	13
% SHREDDERS	2%	2
% SCRAPERS	3%	3
% PREDATORS	9%	5
Scraper/(Scraper+Filterer)	4%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Battle Creek at reference site - 6/24/94

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Gyrinus sp.	2	0.7%
DIPTERA		
Thienemannimyia gp.	1	0.3%
Nilotanypus sp.	1	0.3%
Corynoneura sp.	1	0.3%
Cricotopus sp.	10	3.5%
Polypedilum sp.	1	0.3%
Rheotanytarsus sp.	17	5.9%
Hemerodromia sp.	3	1.0%
Simulium spp. (Psilozoa)	62	21.5%
EPHEMEROPTERA		
Baetis tricaudatus	16	5.6%
"Psuedocloeon"	8	2.8%
Acentrella insignificans	5	1.7%
Leucrocuta sp.	5	1.7%
Isonychia sp.	4	1.4%
Caenis sp.	1	0.3%
Tricorythodes sp.	1	0.3%
TRICHOPTERA		
Ceratopsyche morosa	78	27.1%
Cheumatopsyche spp.	56	19.4%
Hydroptila sp.	4	1.4%
HEMIPTERA		
Corrixidae	2	0.7%
MOLLUSCA		
Planorbiidae	1	0.3%
Physidae	4	1.4%
Sphaeriidae	3	1.0%
CRUSTACEA		
Hyalella azteca	2	0.7%
IDs by D. McGuire	1/8th of sample used	also present Ephoron, Ceraclea, Ferrissia

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
Battle Creek at reference site - 6/24/94

Taxon	300 organism subsample	% relative abundance
TOTAL ORGANISMS	288	
TAXA RICHNESS	24	
EPT RICHNESS	10	
BIOTIC INDEX	5.53	
% DOMINANT TAXON	27%	
% EPT	62%	
% COLLECTORS (g+f)	93%	
% SCRAPERS + SHREDDERS	3%	
% Hydropsychinae of TRICH	97%	
METALS TOLERANCE INDEX	5.03	
% Baetidae of EPHEM.	73%	
SHANNON DIVERSITY	3.18	
EPT/(EPT + Chironomidae)	0.85	
HBI- CTQa	102	
% COLEOPTERA	1%	
% DIPTERA	33%	
% CHIRONOMIDAE	11%	
% EPHEMEROPTERA	14%	
% PLECOPTERA	0%	
% TRICHOPTERA	48%	
% multivoltine	44%	
% univoltine	56%	
% semivoltine	0%	
FFG	% RA	# of taxa
% FILTERERS	76%	6
% COLLECTOR-GATHERERS	17%	10
% SHREDDERS	0%	0
% SCRAPERS	3%	3
% PREDATORS	3%	5
Scraper/(Scraper+Filterer)	4%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
WOOD ISLAND COULEE - 6/23/94

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Optioservus spp.	9	2.9%
Dytiscidae	1	0.3%
DIPTERA		
Thienemannimyia gp.	1	0.3%
Cricotopus sp.	8	2.6%
Cryptochironomus sp.	1	0.3%
Stictochironomus sp.	1	0.3%
Xenochironomus sp.	2	0.7%
Micropsectra sp.	2	0.7%
Rheotanytarsus sp.	27	8.8%
Dicranota sp.	1	0.3%
Simulium spp. (Psilozoa)	97	31.7%
EPHEMEROPTERA		
Caenis sp.	3	1.0%
TRICHOPTERA		
Hydroptila sp.	1	0.3%
Polycentropus sp.	1	0.3%
Mystacides sp.	1	0.3%
Helicopsyche sp.	9	2.9%
HEMIPTERA		
Corrixidae	8	2.6%
ANNELIDA		
Erpobdellidae	3	1.0%
MOLLUSCA		
Planorbiidae	1	0.3%
CRUSTACEA		
Gammarus sp.	118	38.6%
Hyalella azteca	11	3.6%
OTHER		
Porifera	present	0.0%

IDs by D. McGuire

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
WOOD ISLAND COULEE - 6/23/94

Taxon	300 organism subsample	% relative abundance
TOTAL ORGANISMS	306	
TAXA RICHNESS	21	
EPT RICHNESS	5	
BIOTIC INDEX	5.48	
% DOMINANT TAXON	39%	
% EPT	5%	
% COLLECTORS (g+f)	53%	
% SCRAPERS + SHREDDERS	42%	
% Hydropsychinae of TRICH	0%	
METALS TOLERANCE INDEX	3.54	
% Baetidae of EPHEM.	0%	
SHANNON DIVERSITY	2.58	
EPT/(EPT + Chironomidae)	0.26	
HBI- CTQa	100	
% COLEOPTERA	3%	
% DIPTERA	46%	
% CHIRONOMIDAE	14%	
% EPHEMEROPTERA	1%	
% PLECOPTERA	0%	
% TRICHOPTERA	4%	
% multivoltine	46%	
% univoltine	54%	
% semivoltine	0%	
FFG	% RA	# of taxa
% FILTERERS	41%	2
% COLLECTOR-GATHERERS	12%	9
% SHREDDERS	39%	1
% SCRAPERS	3%	2
% PREDATORS	6%	7
Scraper/(Scraper+Filterer)	7%	

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
ARMSTRONG SPRING CREEK @ reference site - July 20, 1994

Taxon	300 organism subsample	% relative abundance
COLEOPTERA		
Heterlimnius sp.	2	0.7%
DIPTERA		
Pagastia sp.	39	13.5%
Cardiocladius sp.	2	0.7%
Cricotopus sp.	3	1.0%
Eukiefferiella spp.	12	4.2%
Tvetenia sp.	1	0.3%
Tanytarsus sp.	4	1.4%
unknown Tipulidae	2	0.7%
Tipula sp.	1	0.3%
Simulium spp. (Psilozoa)	3	1.0%
EPHEMEROPTERA		
Baetis tricaudatus	116	40.1%
TRICHOPTERA		
Hydroptila sp.	4	1.4%
Glossosoma sp.	1	0.3%
Brachycentrus occidentalis	1	0.3%
Amiocentrus sp.	9	3.1%
ANNELIDA		
Naididae	7	2.4%
MOLLUSCA		
Lymnaeidae	7	2.4%
Planorbiidae	1	0.3%
Physidae	17	5.9%
CRUSTACEA		
Caecidotea sp.	6	2.1%
Gammarus sp.	6	2.1%
OTHER		
Turbellaria	45	15.6%

IDs by D. McGuire - 1/8th of sample used
also present: Hesperoperla, Epeorus albertae, Ephemerella inermis

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples
ARMSTRONG SPRING CREEK @ reference site - July 20, 1994

Taxon	300 organism subsample	% relative abundance
TOTAL ORGANISMS	289	
TAXA RICHNESS	22	
EPT RICHNESS	5	
BIOTIC INDEX	4.45	
% DOMINANT TAXON	40%	
% EPT	45%	
% COLLECTORS (g+f)	72%	
% SCRAPERS + SHREDDERS	11%	
% Hydropsychinae of TRICH	0%	
METALS TOLERANCE INDEX	5.27	
% Baetidae of EPHEM.	100%	
SHANNON DIVERSITY	3.01	
EPT/(EPT + Chironomidae)	0.68	
HBI- CTQa	89	
% COLEOPTERA	1%	
% DIPTERA	23%	
% CHIRONOMIDAE	21%	
% EPHEMEROPTERA	40%	
% PLECOPTERA	0%	
% TRICHOPTERA	5%	
% multivoltine	82%	
% univoltine	18%	
% semivoltine	0%	
FFG	% RA	# of taxa
% FILTERERS	3%	3
% COLLECTOR-GATHERERS	70%	11
% SHREDDERS	2%	2
% SCRAPERS	9%	4
% PREDATORS	16%	2
Scraper/(Scraper+Filterer)	76%	

APPENDIX B

Appendix B. Functional feeding groups, voltinism designation and Biotic index, Metals Tolerance index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.

Taxon	BI	MTI	BCI	FFG	Voltinism
COLEOPTERA					
Elmidae					
Cleptelmis ornata	4	4	104	coll-gatherer	univoltine
Dubiraphia sp.	6	4	104	coll-gatherer	univoltine
Heterlimnius sp.	3	3	104	coll-gatherer	univoltine
Lara sp.	1	1	104	shredder	univoltine
Microcylloepus sp.	5	3	104	coll-gatherer	univoltine
Narpus concolor	2	1	104	shredder	univoltine
Optioservus spp.	5	5	104	coll-gatherer	univoltine
Zaitzevia parvula	4	3	104	coll-gatherer	univoltine
Dryopidae					
Helichus sp.	2	2	108	shredder	univoltine
Dytiscidae	5	7	72	predator	univoltine
Hydrophilidae	5	7	72	predator	univoltine
Gyrinidae					
Gyrinus sp.				predator	univoltine
Haliplidae					
Brychius sp.	5	5	54	shredder	univoltine
DIPTERA					
Chironomidae					
Thienemannimyia gp.	5	4	108	predator	multivoltine
Diamesa sp.	5	9	108	coll-gatherer	multivoltine
Pagastia sp.	2	9	108	coll-gatherer	multivoltine
Potthastia sp.	2	9	108	coll-gatherer	multivoltine
Brillia sp.	4	4	108	shredder	multivoltine
Cardiocladius sp.	5	9	108	predator	multivoltine
Corynoneura sp.	7	4	108	coll-gatherer	multivoltine
Cricotopus sp.	7	9	108	coll-gatherer	multivoltine
Cricotopus nostococladius	6	5	108	shredder	multivoltine
Eukiefferiella spp.	8	9	108	coll-gatherer	multivoltine
Nanocladius sp.	3	4	108	coll-gatherer	multivoltine
Orthocladius sp.	6	5	108	coll-gatherer	multivoltine
Parametriocnemus sp.	5	4	108	coll-gatherer	multivoltine
Paraphaenocladius sp.	4	4	108	coll-gatherer	multivoltine
Pseudosmittia sp.	6	4	108	coll-gatherer	multivoltine
Rheocricotopus sp.	4	5	108	coll-gatherer	multivoltine
Synorthocladius sp.	2	1	108	coll-gatherer	multivoltine
Thienemanniella sp.	6	4	108	coll-gatherer	multivoltine
Tvetenia sp.	5	4	108	coll-gatherer	multivoltine
Cryptochironomus sp.	8	5	108	coll-gatherer	multivoltine
Microtendipes sp.	6	4	108	coll-gatherer	multivoltine

Appendix B. Functional feeding groups, voltinism designation and Biotic index, Metals Tolerance index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.

Taxon	BI	MTI	BCI	FFG	Voltinism
Polypedilum sp.	6	4	108	coll-gatherer	multivoltine
Robackia sp.	4	4	108	coll-gatherer	multivoltine
Micropsectra sp.	4	1	108	coll-gatherer	multivoltine
Tanytarsus sp.	6	3	108	filterer	multivoltine
Rheotanytarsus sp.	6	1	108	filterer	multivoltine
Tipuldae					
Antocha sp.	3	4	24	coll-gatherer	univoltine
Dicranota sp.	3	4	24	predator	univoltine
Hexatoma sp.	2	2	36	predator	univoltine
Pseudolimnophila sp. ?	2	4	72	coll-gatherer	univoltine
Tipula sp.	4	4	36	shredder	univoltine
Rhabdomastix sp.	2	1	24	predator	univoltine
Athericidae					
Atherix sp.	5	5	24	predator	univoltine
Blephariceridae					
Agathon sp.	0	0	2	scraper	univoltine
Deuterophlebiidae					
Deuterophlebia sp.	0	0	4	scraper	univoltine
Psychodidae					
Pericoma sp.	4	4	36	coll-gatherer	univoltine
Empididae	6	4	95	predator	univoltine
Chelifera sp.	6	4	95	predator	univoltine
Clinocera sp.	6	4	95	predator	univoltine
Hemerodromia sp.	6	4	95	predator	univoltine
Ceratopogoninae	6	4	108	predator	multivoltine
Stratiomyiidae	7	4	108	coll-gatherer	univoltine
Simuliidae					
Prosimulium sp.	4	3	108	filterer	multivoltine
Simulium spp. (Psilozoa)	7	7	108	filterer	multivoltine
Simulium spp. (Eusimulium)	5	5	108	filterer	multivoltine
EPHEMEROPTERA					
Baetidae					
Baetis tricaudatus	4	5	72	coll-gatherer	multivoltine
Baetis bicaudatus	2	4	72	coll-gatherer	univoltine
Baetis punctiventris	6	3	72	coll-gatherer	multivoltine
Acentrella insignificans	4	4	72	coll-gatherer	multivoltine
Ephemerellidae					
Attenella margarita	3	1	48	coll-gatherer	univoltine
Caudatella hystrix	0	0	18	coll-gatherer	univoltine
Drunella coloradensis	0	0	18	scraper	univoltine
Drunella doddsi	1	0	4	scraper	univoltine

Appendix B. Functional feeding groups, voltinism designation and Biotic index, Metals Tolerance index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.

Taxon	BI	MTI	BCI	FFG	Voltinism
Drunella grandis	2	1	24	coll-gatherer	univoltine
Drunella spinifera	0	0	24	predator	univoltine
Ephemerella infrequens	2	2	48	coll-gatherer	univoltine
Ephemerella inermis	4	3	48	coll-gatherer	univoltine
Serratella sp.	2	1	24	coll-gatherer	univoltine
Timpanoga hecuba	2	1	48	coll-gatherer	univoltine
Heptageniidae					
Cinygmula sp.	0	0	30	scraper	univoltine
Epeorus albertae	2	0	21	scraper	univoltine
Epeorus deceptivus	0	0	21	scraper	univoltine
Epeorus grandis	0	0	21	scraper	univoltine
Epeorus longimanus	1	0	21	scraper	univoltine
Ironodes sp.	0	0	21	scraper	univoltine
Heptagenia sp.	4	1	54	scraper	univoltine
Nixe sp.	4	1	54	scraper	univoltine
Rhithrogena sp.	0	2	21	scraper	univoltine
Siphlonuridae					
Ameletus sp.	0	1	48	coll-gatherer	univoltine
Tricorythidae					
Tricorythodes sp.	4	4	108	coll-gatherer	multivoltine
Leptophlebiidae					
Choroterpes sp.	2	1	36	coll-gatherer	univoltine
Paraleptophlebia bicornuta	2	1	24	coll-gatherer	univoltine
Paraleptophlebia sp.	1	1	24	coll-gatherer	univoltine
PLECOPTERA					
Chloroperlidae					
Chloroperlinae	1	2	24	predator	univoltine
Kathroperla sp.	1	2	24	predator	univoltine
Capniidae	1	0	24	shredder	univoltine
Leuctridae	0	0	18	shredder	univoltine
Nemouridae					
Amphinemura sp.	2	1	6	shredder	univoltine
Malenka sp.	1	1	36	shredder	univoltine
Podmosta sp.	2	1	12	shredder	univoltine
Visoka cataractae	0	0	6	shredder	univoltine
Zapada cinctipes	3	3	16	shredder	univoltine
Zapada oregenensis gp.	2	1	16	shredder	univoltine
Peltoperlidae					
Yoraperla sp.	0	0	12	shredder	univoltine
Pteronarcidae					
Pteronarcella sp.	4	4	24	shredder	univoltine

Appendix B. Functional feeding groups, voltinism designation and Biotic index, Metals Tolerance index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.

Taxon	BI	MTI	BCI	FFG	Voltinism
Pteronarcys sp.	2	2	18	shredder	semivoltine
Perlidae					
Calineuria californica	2	3	18	predator	semivoltine
Claassinia sabulosa	3	3	6	predator	semivoltine
Hesperoperla pacifica	1	3	18	predator	semivoltine
Doroneuria sp.	0	2	18	predator	semivoltine
Perlodidae					
Isoperla sp.	2	3	48	predator	univoltine
Cultus sp.	2	2	12	predator	univoltine
Isogenoides sp.	3	2	24	predator	univoltine
Kogotus sp.	1	2	18	predator	univoltine
Megarcys sp.	1	1	24	predator	univoltine
Pictetiella sp.	0	2	18	predator	univoltine
Skwala sp.	3	3	18	predator	univoltine
TRICHOPTERA					
Hydropsychidae					
Hydropsyche spp.	5	5	108	filterer	univoltine
Ceratopsyche spp.	5	5	108	filterer	univoltine
Cheumatopsyche spp.	5	5	108	filterer	univoltine
Arctopsyche sp.	2	3	18	filterer	univoltine
Parapsyche sp.	0	1	6	filterer	semivoltine
Hydroptilidae					
Agraylea sp.	8	2	108	coll-gatherer	multivoltine
Hydroptila sp.	6	4	108	coll-gatherer	multivoltine
Leucotrichia sp.	2	1	108	scraper	univoltine
Ochrotrichia sp.	4	3	108	coll-gatherer	univoltine
Limnephilidae					
Apatania sp.	3	2	18	scraper	univoltine
Chryandra sp.	2	2	18	shredder	univoltine
Dicosmoecus sp.	2	1	24	scraper	semivoltine
Ecclisomyia sp.	4	2	24	coll-gatherer	univoltine
Neophylax sp.	3	2	24	scraper	univoltine
Neothremma sp.	1	1	8	scraper	univoltine
Oligophlebodes sp.	3	1	24	scraper	univoltine
Psychoglypha sp.	0	2	24	coll-gatherer	univoltine
Glossosomatidae					
Agapetus sp.	0	2	24	scraper	univoltine
Glossosoma sp.	0	2	24	scraper	univoltine
Lepidostomatidae					
Lepidostoma sp.	1	1	18	shredder	univoltine
Brachycentridae					

Appendix B. Functional feeding groups, voltinism designation and Biotic index, Metals Tolerance index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.

Taxon	BI	MTI	BCI	FFG	Voltinism
Brachycentrus americanus	1	4	24	scraper	univoltine
Brachycentrus occidentalis	2	3	24	filterer	univoltine
Micrasema sp.	1	2	24	shredder	univoltine
Leptoceridae					
Nectopsyche sp.	2	3	54	shredder	univoltine
Oecetis sp.	8	3	54	predator	univoltine
Philopotamidae					
Dolphilodes sp.	0	1	24	filterer	univoltine
Wormaldia sp.	0	1	24	filterer	univoltine
Polycentropodidae					
Polycentopus sp.	6	1	72	predator	univoltine
Rhyacophilidae					
Rhyacophila alberta gp.	0	1	18	predator	univoltine
Rhyacophila angelita gp.	0	1	18	predator	univoltine
Rhyacophila betteni gp.	0	1	18	predator	univoltine
Rhyacophila brunnea gp.	2	1	18	predator	univoltine
Rhyacophila coloradensis gp.	0	1	18	predator	semivoltine
Rhyacophila hyalinata gp.	0	1	18	predator	univoltine
Rhyacophila sibirica gp.	0	1	18	predator	univoltine
Rhyacophila verrula	0	1	18	predator	univoltine
Rhyacophila vofixa gp.	0	1	18	predator	univoltine
Helicopsychidae					
Helicopsyche b.	3	3	18	scraper	univoltine
LEPIDOPTERA					
Pyralidae					
Petrophila sp.	5	3	72	scraper	univoltine
ODONATA					
Gomphidae					
Ophiogomphus sp.	5	3	108	predator	semivoltine
ANNELIDA					
Erpobdellidae					
Glossiphoniidae					
Helobdella stagnalis	10	4	108	predator	univoltine
Enchytraeidae	4	1	108	coll-gatherer	univoltine
Lumbricidae	4	1	108	coll-gatherer	univoltine
Lumbriculidae	4	1	108	coll-gatherer	univoltine
Naididae	8	5	108	coll-gatherer	multivoltine
Tubificidae	10	6	108	coll-gatherer	multivoltine

Appendix B. Functional feeding groups, voltinism designation and Biotic index, Metals Tolerance index and BCI tolerance values for selected aquatic macroinvertebrates from Montana.

Taxon	BI	MTI	BCI	FFG	Voltinism
MO MOLLUSCA					
Lymnaeidae	6	3	108	scraper	univoltine
Planorbiidae	6	3	108	scraper	univoltine
Physidae	8	4	108	scraper	univoltine
Sphaeriidae	8	3	108	filterer	univoltine
CRUSTACEA					
Decapoda	6	3	72	shredder	semivoltine
Gammaridae					
Gammarus sp.	4	3	98	shredder	univoltine
Talitridae					
Hyalella azteca	8	3	98	coll-gatherer	univoltine
Turbellaria	4	4	108	predator	multivoltine